

1 (BSP September 8, 2003)

2 **Shafts For Signal Standard Foundations**

3 Shaft foundations for the traffic signal standards at the following location(s) shall be  
4 constructed in accordance with the following requirements:

5 \*\*\*\$\$1\$\$\*\*\*  
6

7  
8 **Submittals**

9 Prior to the start of drilled shaft construction, the Contractor shall submit four  
10 copies of a project reference list to the Engineer for approval verifying the  
11 successful completion by the Contractor of at least three separate shaft  
12 foundation projects within the past five years with drilled shafts of diameters,  
13 depths, and ground conditions equal to or larger than those shown in the  
14 Plans. A brief description of each project and the owner's contact person's  
15 name and current phone number shall be included for each project listed.  
16

17 Prior to the start of drilled shaft construction, the Contractor shall submit four  
18 copies of a list identifying the on-site supervisors, and drill rig operators  
19 assigned to the project to the Engineer for approval. On-site supervisors shall  
20 have a minimum two years experience in supervising construction of drilled  
21 shaft foundations, and drill rig operators shall have a minimum one year  
22 experience in construction of drilled shaft foundations. The list shall contain a  
23 summary of each individual's experience.  
24

25 The Engineer will approve or reject the Contractor's qualifications and field  
26 personnel within 10 working days after receipt of the submission. Work shall  
27 not be started on any drilled shaft until the Contractor's qualifications and field  
28 personnel are approved by the Engineer. The Engineer may suspend the  
29 drilled shaft construction if the Contractor substitutes unqualified personnel.  
30 The Contractor shall be fully liable for the additional costs resulting from the  
31 suspension of work and no adjustments in contract time resulting from the  
32 suspension of work will be allowed.  
33

34 The Contractor shall submit four copies of a shaft installation narrative for  
35 approval by the Engineer. In preparing the narrative, the Contractor shall  
36 reference the available subsurface data provided in the contract test hole  
37 boring logs, and the geotechnical report(s) prepared for this project. This  
38 narrative shall provide at least the following information:  
39

- 40 1. An overall construction operation sequence and the sequence of  
41 drilled shaft construction.  
42
- 43 2. List, description and capacities of proposed equipment, including but  
44 not limited to cranes, drills, auger, bailing buckets, final cleaning  
45 equipment and drilling unit. The narrative shall describe why the  
46 equipment was selected, and describe equipment suitability to the  
47 anticipated site and subsurface conditions. The narrative shall  
48 include a project history of the drilling equipment demonstrating the  
49 successful use of the equipment on shafts of equal or greater size in  
50 similar soil/rock conditions.  
51

- 1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20
3. Details of shaft excavation methods, including proposed drilling methods, methods for cleanout of the shafts and a disposal plan for excavated material and drilling slurry (if applicable). This shall include a review of method suitability to the anticipated site and subsurface conditions.
  4. Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using casing, slurry, or other means) during excavation and concrete placement. This shall include a review of method suitability to the anticipated site and subsurface conditions. Casing dimensions and detailed procedures for permanent casing installation, and methods of advancing permanent casing with the excavation in accordance with this Special Provision, shall be provided.
  5. Detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided. A detailed mix design, and a discussion of its suitability to the anticipated subsurface conditions, shall also be provided for the proposed slurry.

21  
22  
23  
24  
25  
26  
27  
28  
29

The submittal shall include a detailed plan for quality control of the selected slurry, including tests to be performed, test methods to be used, and minimum and/or maximum property requirements which shall be met to ensure that the slurry functions as intended, considering the anticipated subsurface conditions and shaft construction methods, in accordance with the slurry manufacturer's recommendations and this Special Provision. As a minimum, the slurry quality control plan shall include the following tests:

**Property    Test Method**

Density    Mud Weight (Density), API 13B-1, Section 1

Viscosity    Marsh Funnel and Cup,  
API 13B-1, Section 2.2

PH    Glass Electrode, pH Meter, or pH Paper

Sand    Sand, API 13B-1, Section 5  
Content

- 30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40
6. The method used to fill or eliminate all voids below the top of shaft between the permanent shaft casing and surrounding soil.
  7. Reinforcing steel shop drawings, details of reinforcement placement, including bracing, centering, and lifting methods, and the method to assure the reinforcing cage position is maintained during construction.
  8. Details of concrete placement, including proposed operational procedures for pumping and/or tremie methods.

9. Details of the device used to prevent unauthorized entry into a shaft excavation.
10. Description of the material used to temporarily backfill a shaft excavation during a stoppage of the excavation operation, as well as the method used to place and remove the material.

The Engineer will evaluate the shaft installation plan for conformance with the Plans, Specifications and Special Provisions.

If synthetic slurry is used to construct the shafts, the Contractor shall provide or arrange for technical assistance in the use of the synthetic slurry as specified in the **Slurry** subsection of this Special Provision. The Contractor shall submit four copies of one of the following to the Engineer for approval:

1. The name and current phone number of the synthetic slurry manufacturer's technical representative assigned to the project.
2. The name(s) of the Contractor's personnel assigned to the project and trained by the synthetic slurry manufacturer in the proper use of the synthetic slurry. The submittal shall include a signed training certification letter from the synthetic slurry manufacturer for each trained Contractor's employee listed, including the date of the training.

Work shall not begin until all the required submittals have been approved in writing by the Engineer. All procedural approvals given by the Engineer will be subject to trial in the field and shall not relieve the Contractor of the responsibility to satisfactorily complete the work.

#### **Quality Assurance**

Shafts shall be constructed so that the center at the top of the shaft is within four inches of the Plan location. Shafts shall be within 1.5 percent of plumb. Shaft steel reinforcing bar placement tolerances shall conform to Section 6-02.3(24)C.

A shaft preconstruction conference shall be held at least five working days prior to the Contractor beginning any shaft construction work at the site to discuss construction procedures, personnel, and equipment to be used, and other elements of the approved shaft installation plan as specified elsewhere in this Special Provision. The list of materials specified in the Record Of Materials (ROM) form for this item of work will also be discussed. Those attending shall include:

1. (representing the Contractor) The superintendent, on site supervisors, and all foremen in charge of excavating the shaft, placing the casing and slurry as applicable, placing the steel reinforcing bars, and placing the concrete.
2. (representing the Contracting Agency) The Project Engineer, key inspection personnel, and representatives from the WSDOT

If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved shaft installation plan, an additional conference shall be held before any additional shaft construction operations are performed.

#### **Shaft Excavation**

Shafts shall be excavated to the required depth as shown in the Plans or as directed by the Engineer. Once the excavation operation has been started, the excavation shall be conducted in a continuous operation until the excavation of the shaft is completed, except for pauses and stops as noted, using approved equipment capable of excavating through the type of material expected. Pauses during this excavation operation, except for casing splicing and removal of obstructions, are not allowed. The Contractor shall provide casing at the site in sufficient quantities to meet the needs of the anticipated construction method.

Pauses, defined as momentary interruptions of the excavation operation, will be allowed only for casing splicing and removal of obstructions. Shaft excavation operation interruptions not conforming to this definition shall be considered stops.

If the shaft excavation is not complete at the end of the shift or series of continuous shifts, the shaft excavation operation may be stopped, provided the following conditions are met. The Contractor shall, before the end of the work day, either install casing in the hole to the depth of the excavation and either the Plan diameter of the shaft or the actual excavated diameter of the hole, whichever is greater, or backfill the hole with material approved by the Engineer in accordance with item 10 of the shaft installation plan as approved by the Engineer. The Contractor shall backfill the hole to the ground surface, if the excavation is not cased, or to a minimum of five feet above the bottom of casing, if the excavation is cased. Backfilling of shafts with casing fully seated into rock, as determined by the Engineer, will not be required. If slurry is present in the shaft excavation, the Contractor shall conform to the requirements in the **Slurry** subsection of this Special Provision regarding the maintenance of the minimum level of drilling slurry throughout the stoppage of the shaft excavation operation, and shall recondition the slurry to the required slurry properties prior to recommencing shaft excavation operations.

Permanent casing is required full depth for all traffic signal standard shaft foundation locations specified at the beginning of this Special Provision.

The Contractor shall conduct casing installation operations and shaft excavation operations such that the adjacent soil outside the casing and shaft excavation for the full height of the shaft is not disturbed. Disturbed soil is defined as soil whose geotechnical properties have been changed from those of the original in-situ soil, and whose altered condition adversely affects the structural integrity of the shaft foundation.

1 Shaft excavations shall not be left open overnight. An open shaft excavation is  
2 defined as a shaft excavation that has not been filled with concrete, or  
3 temporarily backfilled with a material approved by the Engineer in accordance  
4 with item 10 of the shaft installation plan as approved by the Engineer.

5  
6 The Contractor shall use appropriate means such as a cleanout bucket or air  
7 lift to clean the bottom of the excavation of all shafts. No more than six inches  
8 of loose or disturbed material shall be present at the bottom of the shaft just  
9 prior to placing concrete.

10  
11 The excavated shaft shall be inspected and approved by the Engineer prior to  
12 proceeding with construction. The bottom of the excavated shaft shall be  
13 sounded with an airlift pipe, a tape with a heavy weight attached to the end of  
14 the tape, or other means acceptable to the Engineer to determine that the  
15 shaft bottom meets the requirements in the Contract.

16  
17 When obstructions are encountered, the Contractor shall notify the Engineer  
18 promptly. An obstruction is defined as a specific object (including, but not  
19 limited to, boulders, logs, and man made objects) encountered during the shaft  
20 excavation operation which prevents or hinders the advance of the shaft  
21 excavation. When efforts to advance past the obstruction to the design shaft  
22 tip elevation result in the rate of advance of the shaft drilling equipment being  
23 significantly reduced relative to the rate of advance for the rest of the shaft  
24 excavation, then the Contractor shall remove the obstruction under the  
25 provisions of Section 8-20.5 as supplemented in these Special Provisions.  
26 The method of removal of such obstructions, and the continuation of  
27 excavation shall be as proposed by the Contractor and approved by the  
28 Engineer.

### 29 30 **Slurry**

31 If synthetic slurry is used, either a manufacturer's representative or a  
32 Contractor's employee trained in the use of the synthetic slurry, as approved  
33 by the Engineer in accordance with the **Submittals** subsection of this Special  
34 Provision, shall provide technical assistance for the use of the synthetic slurry,  
35 shall be at the site prior to introduction of the synthetic slurry into a drilled hole,  
36 and shall remain at the site during the construction and completion of a  
37 minimum of one shaft to adjust the slurry mix to the specific site conditions.

38  
39 If the Contractor uses slurry in shafts installed below groundwater and in  
40 caving or sloughing soils, the slurry level in the excavation shall be maintained  
41 above the groundwater level the greater of the following dimensions, except as  
42 otherwise noted for the special requirements for all stops in shaft excavation  
43 operations:

- 44  
45 1. Not less than ten feet for synthetic and water slurries,  
46  
47 2. Dimension as required to provide and maintain a stable hole.

48  
49 The Contractor shall provide casing, or other means, as necessary to meet  
50 these requirements.  
51

1 The slurry level shall be maintained above all unstable zones a sufficient  
2 distance to prevent bottom heave, caving or sloughing of those zones.  
3

4 Throughout all stops in shaft excavation operations as defined in the **Shaft**  
5 **Excavation** subsection of this Special Provision, the Contractor shall monitor  
6 and maintain the slurry level in the excavation the greater of the following  
7 elevations:  
8

- 9 1. No lower than the water level elevation outside the shaft.
- 10 2. Elevation as required to provide and maintain a stable hole.
- 11
- 12

13 The Contractor shall sample and test all slurry in the presence of the Engineer,  
14 unless otherwise directed. The date, time, names of the persons sampling and  
15 testing the slurry, and the results of the tests shall be recorded. A copy of the  
16 recorded slurry test results shall be submitted to the Engineer at the  
17 completion of each shaft, and during construction of each shaft when  
18 requested by the Engineer.  
19

20 Sample sets of all slurry, composed of samples taken at mid-height and within  
21 two feet of the bottom of the shaft, shall be taken and tested during drilling as  
22 necessary to verify the control of the properties of the slurry. As a minimum,  
23 sample sets of all slurry shall be taken and tested at least once every two  
24 hours if the slurry is not recirculated in the drilled hole or if the previous sample  
25 set did not have consistent specified properties. All slurry shall be recirculated,  
26 or agitated with the drilling equipment, when tests show that the sample sets  
27 do not have consistent specified properties.  
28

29 Sample sets of all slurry, as specified, shall be taken and tested prior to final  
30 cleaning of the bottom of the hole and again just prior to placing concrete.  
31 Cleaning of the bottom of the hole and placement of the concrete shall not  
32 start until tests show that the samples taken at mid-height and within two feet  
33 of the bottom of the hole have consistent specified properties.  
34

35 The Contractor shall clean, recirculate, de-sand, or replace the slurry to  
36 maintain the required slurry properties.  
37

38 The Contractor shall demonstrate to the satisfaction of the Engineer that stable  
39 conditions are being maintained. If the Engineer determines that stable  
40 conditions are not being maintained, the Contractor shall immediately take  
41 action to stabilize the shaft. The Contractor shall submit a revised shaft  
42 installation plan which addresses the problem and prevents future instability.  
43 The Contractor shall not continue with shaft construction until the damage  
44 which has already occurred is repaired in accordance with the specifications,  
45 and until receiving the Engineer's approval of the revised shaft installation  
46 plan.  
47

#### 48 **Assembly And Placement Of Steel Reinforcing Bars**

49 The steel reinforcing bar cage shall be rigidly braced to retain its configuration  
50 during handling and construction. Individual or loose bars will not be  
51 permitted. The Contractor shall show bracing and any extra reinforcing steel  
52 required for fabrication of the cage in the shop drawings.

The reinforcement shall be carefully positioned and securely fastened to provide the minimum clearances listed below, and to ensure that no displacement of the steel reinforcing bars occurs during placement of the concrete. The Contractor shall submit details of the proposed reinforcing cage spacers along with the shop drawings.

Place bars as shown in the Plans with minimum concrete cover of three inches for shafts with diameters of three feet or less, and four inches for shafts with diameters greater than three feet.

### **Placing Concrete**

Shaft concrete shall be Class 4000P. Concrete placement shall commence immediately after completion of excavation by the Contractor and inspection by the Engineer. Immediately prior to commencing concrete placement, the shaft excavation and the properties of the slurry (if used) shall conform to the excavation and slurry requirements specified elsewhere in this Special Provision. Concrete placement shall continue in one operation to the top of the shaft, or as shown in the Plans.

When placing concrete in the dry, only the top five feet of concrete shall be vibrated. If a temporary casing is used it shall be removed before vibration. This requirement may be waived if a temporary casing is used and removed with a vibratory hammer during the concrete placement operation. Vibration of the top five feet of concrete does not affect the maximum slump allowed for the concrete class specified.

If water is not present, the concrete shall be deposited through the center of the reinforcement cage by a method which prevents segregation of aggregates and splashing of concrete on the reinforcement cage. The concrete shall be placed such that the free-fall is vertical down the center of the shaft without hitting the sides, the steel reinforcing bars, or the steel reinforcing bar cage bracing.

When placing concrete underwater, the Contractor shall use a concrete pump or tremie. A tremie shall have a hopper at the top that empties into a watertight tube at least eight inches in diameter. If a pump is used, a watertight tube shall be used with a minimum diameter of four inches. The discharge end of the tube on the tremie or concrete pump shall include a device to seal out water while the tube is first filled with concrete.

Throughout the underwater concrete placement operation, the discharge end of the tube shall remain submerged in the concrete at least five feet and the tube shall always contain enough concrete to prevent water from entering. The concrete placement shall be continuous until the work is completed, resulting in a seamless, uniform shaft.

Before placing any fresh concrete against concrete deposited in water or slurry, the Contractor shall remove all scum, laitance, loose gravel and sediment on the upper surface of the concrete deposited in water or slurry and chip off any high spots on the upper surface of the existing concrete that would

- 1 prevent the steel reinforcing bar cage from being placed in the position
- 2 required by the Plans.
- 3
- 4 **Casing Removal**
- 5 Tops of permanent casings for the shafts shall be removed to the top of the
- 6 shaft as shown in the Plans, unless directed otherwise by the Engineer.